DESIGN AND WIDENING OF THE NEWTOWN BRIDGE TO ENHANCE ACCESSIBILITY TO QUIRINO HIGHWAY

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In Partial Fulfillment of the Requirements for the Degree

Bachelor of Science in Civil Engineering

Major in Construction Engineering

And Management

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RECOMMENDATION

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We hereby certify that this thesis is our own work and that, to the best of our knowledge and belief, it contains no material previously written or published by another person or organization nor any material which has been accepted for the award of any other degree or diploma from a university or institution of higher learning, except where due acknowledgement is made thereof.

Furthermore, we declare that the intellectual content of this thesis is the product of our work. However, we have received assistance from others in the manner of organization, presentation, language, and style.

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Chapter 1

The Problem and its Background

This chapter presents an overview of the study, including the introduction, background of the study, theoretical framework, statement of the problem, hypothesis, scope and limitations of the study, significance of the study, and definition of terms.

Introduction

Bridges are among the most remarkable achievements of civil engineering, as they serve as vital connectors that enable mobility, economic growth, and social interaction. Beyond their architectural appearance or beauty, bridges play a crucial role in linking communities separated by rivers, valleys, and any other geographical barrier; they ensure the continuous flow of goods, services, and people who walk or run on them. Globally speaking, well-designed bridges can contribute to national productivity and development by reducing travel time, enhancing trade, and stimulating tourism

The Philippines is an archipelago that comprises more than 7,600 islands, and bridges are especially significant. They not only connect provinces and municipalities but also the reasons for economic growth and regional development. One of the most remarkable examples is the San Juanico Bridge, which has long demonstrated how infrastructure can promote both economic activity and social unity between islands. However, not all bridges in the country share this level of reliability. Many, particularly in developing areas, have deteriorated due to age and corrosion in some vital parts of the bridge. For example, the Newtown Bridge in Towerville. Over time, it has suffered

from rusting steel components, brittle materials, and visible surface damage, such as the steel deck of the bridge. It limits its own purpose to serve the community and people around it. And also, the deterioration of the bridge causes heavy traffic on the Quirino Highway.

Acknowledging the need, the present study focuses on the design and widening of the Newtown Bridge to enhance accessibility to the Quirino Highway. By integrating the principle of structural engineering and transportation Infrastructure Development, the research seems to provide a technically sound and economically feasible design solution that ensures safety, durability, and improved mobility for the residents and the surrounding community**.**

Background of the Study

The Newtown Bridge, which is located in Towerville, serves as a vital access route for neighboring communities connecting to Quirino Highway, a major road network that supports transportation, trade, and local development within the area. Over time, this bridge has experienced significant deterioration, including corrosion of steel components, cracking of the deck, and the weakening of load-bearing structures. Combining this with the increasing traffic demands, it is limiting the bridge's capacity to the safety and efficiently accommodate vehicles and pedestrians. Also, this bridge is no longer functioning, so it worsens the traffic on the main road.

Bridge deterioration is a growing concern in many parts of the Philippines. According to the Department of Public Works and Highways (DPWH, 2022), a large

number of the country's bridges are aging and in need of repair or replacement due to exposure to environmental factors such as rain and extreme heat, and also the increased loading conditions. In a study conducted by Rjay (2019) at the National Graduate Institute for Policy Studies, he found that structural rehabilitation and proper bridge design play a crucial role in reducing maintenance costs and enhancing the service life of bridges. With the similar study of Cruz and Garcia (2020) on the Rehabilitation of Barangay Sta. Monica Bridge in Quezon City, as it emphasized that bridge widening and strengthening improve load capacity and community accessibility. In the context of Towerville, the existing Newtown bridge no longer meets the growing transportation and safety requirements of the area.

Looking at the observed problem and the insufficient width of the structure, there's a clear need for an upgraded design that will accommodate a large volume of vehicles and the demand of pedestrians. Also, widening this bridge will not only address the current traffic congestion but also support urban growth and ensure long-term structural reliability.

To improve accessibility to Quirino Highway, this study focuses on the design and enlargement of the Newtown Bridge. To provide a solution that is both economical and structurally sound, it seeks to integrate contemporary design principles and engineering standards. The project hopes that this initiative will help the Towerville community and its surrounding areas become more mobile, safer, and economically vibrant overall.

1.3 Theoretical Framework

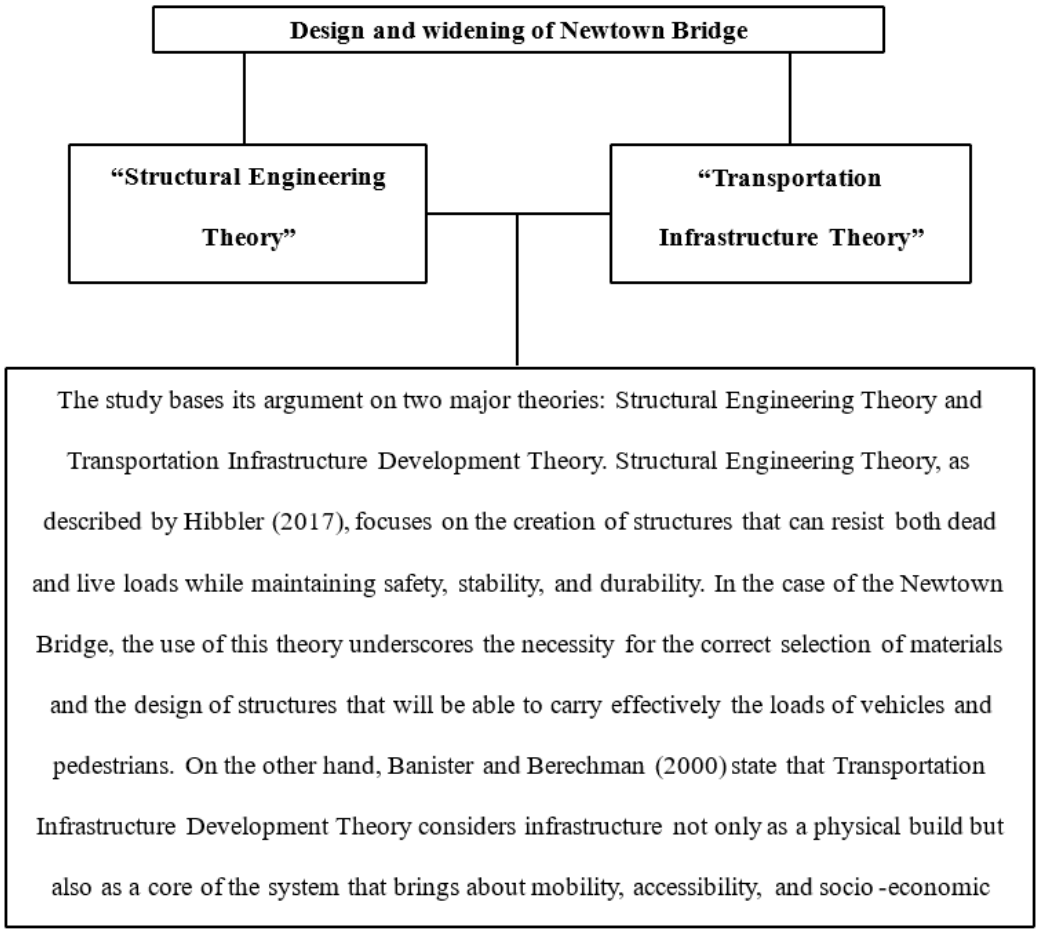
Design and widening of Newtown Bridge
"Structural Engineering Theory"
"Transportation Infrastructure Theory"
The study bases its argument on two major theories: Structural Engineering Theory and Transportation Infrastructure Development Theory. Structural Engineering Theory, as described by Hibbler (2017), focuses on the creation of structures that can resist both dead and live loads while maintaining safety, stability, and durability. In the case of the Newtown Bridge, the use of this theory underscores the necessity for the correct selection of materials and the design of structures that will be able to carry effectively the loads of vehicles and pedestrians. On the other hand, Banister and Berechman (2000) state that Transportation Infrastructure Development Theory considers infrastructure not only as a physical build but also as a core of the system that brings about mobility, accessibility, and socio-economic

Figure 1: *The theoretical framework illustrates theories from different studies.*

IPO Conceptual Framework

Input	**Process**	**Output**
1. How can the demographic profile of the residents and commuters be described in terms of: 1.1 Age 1.2 Gender 1.3 Occupation.	Conducting a survey questionnaire among the residents near the Newtown Bridge and commuters.	
2. How can the design considerations be combined into the proposed Newtown Bridge in terms of: 2.1 Structural stability and integrity	Perform a preliminary bridge design using engineering by using Auto-CAD or STAAD to analyze and determine the correct dimensions, stability, and load capacity of the proposed bridge.	

2.2 Capacity to accommodate projected vehicles and pedestrian demand.		
3. How can the proposed design ensure cost-efficiency and practicability in terms of: 3.1 Use of sustainable and standard materials. 3.2 Estimated lifespan of the bridge structure.	Selecting proper and suitable materials and construction approaches based on the availability, cost, and performance.	

4. How can the proposed developments be Applied to the bridge in terms of: 4.1 Widening to address traffic demand 4.2 Enhancing accessibility for all users.	Create a plan for widening of the bridge using AutoCAD to ensure that future traffic demands and pedestrians are accommodated	
5. How will the design and widening of the Newtown Bridge benefits the community in terms of: 5.1 Improving mobility and connectivity.	Data collection and analysis through a survey.	

5.2 Promoting long-term sustainability of infrastructure.		

Figure 1: *The theoretical framework illustrates theories from different studies.*

Statement of the problem

The New Town Bridge is a vital transportation structure that connects communities and supports local mobility. However, concerns have been raised with regard to its safety, accessibility, and capacity to accommodate the growing number of residents and users of the bridge. With the increasing traffic demands and community needs, the current condition of the bridge really needs to be addressed, and it calls for immediate reassessment of its design and functionality. To answer all these problems, this study focuses on the design and widening of the Newtown Bridge to enhance its safety, efficiency, and sustainability; specifically, it seeks to answer the following questions:

1. How can the demographic profile of the local residents and commuters be described in terms of:

    1.1 Age

    1.2 Gender

    1.3 Occupation

2. How can the design considerations be combined into the proposed Newtown Bridge in terms of:

    2.1 Structural Stability and Integrity.

    2.2 Capacity to accommodate projected vehicles and pedestrian demand.

3. How can the proposed design ensure cost-efficiency and practicability in terms of:

    3.1 Use of sustainable and standard materials.

    3.2 Estimated lifespan of the bridge structure.

4. How can the proposed developments be applied to the bridge in terms of:

    4.1 Widening to address traffic demand.

    4.2 Enhancing accessibility for all users.

5. How will the design and widening of the Newtown Bridge benefit the community in terms of:

    5.1 Improving mobility and connectivity.

    5.2 Promoting long-term sustainability of infrastructure.

Objective of the Study

The main focus of this study is to underline the problem of Newtown Bridge and how the proposed design will help alleviate the traffic congestion on Quirino Highway along Towerville. This study seeks to establish the strategic approach of the Newtown Bridge proposed project. The results of this are used to:

To assess the problem of traffic conditions of the main road and the Newtown Bridge, traffic congestion in terms of volume, peak hour congestion, and the types of vehicles. It involves conducting a survey of traffic to gather empirical data.

To locate the bottleneck effect of the existing bridge, which is not usable at this time due to the current condition, and cannot aid in the traffic slowdowns and congestion on the main road.

To conduct a detailed cost-benefit analysis of the new Newtown bridge widening proposed project, anticipating construction costs, land procurement, and long-term use and maintenance, versus the economic benefits of reducing the travel time due to the traffic congestion, and possibly increasing commercial activity.

To evaluate the structural integrity and load-bearing capacity of the proposed project of Newtown Bridge to underline the feasibility of a widening or reconstruction plan.

To forecast the future traffic flow and congestion levels: for the next years, or better in decades, to validate or prove that the proposed bridge design is sturdy enough to handle the anticipated growth in vehicle traffic

Research Hypotheses

Ho:

There is no significant difference in the proposed design and widening of Newtown Bridge in enhancing accessibility to Quirino Highway.

Ha:

There is a significant difference between the proposed design and the widening of Newtown Bridge in enhancing accessibility to Quirino Highway

Scope and Limitation

This study focuses on the evaluation and design considerations as well as the widening of the Newtown Bridge, a vital transportation structure that connects local communities. In particular, this study will examine the current condition of the bridge in terms of structural stability, safety features, accessibility, mobility, and overall usability for both vehicles and pedestrians. Additionally, this study will also include the total cost estimation of the bridge to determine the financial requirements. For data gathering, it will be obtained through site observation, secondary sources such as previous engineering reports, and government documents. And lastly, from the feedback of the residents near the Newtown Bridge.

This study will not cover the actual construction of the full project implementation of the proposed design and widening of the Newtown Bridge. Although cost estimation is included, it will be limited to a preliminary analysis and

will not reflect the final expenses of a real project. This study is also limited to the Newton Bridge alone and does not compare it with the other bridges. Also, the scope of technical testing is limited by the availability of resources, since advanced engineering tests and long-term monitoring are beyond the scope of this study. Lastly, the findings of this study are mainly for academic purposes and may still need further review by professional engineers and government authorities.

Definition of terms

Architectural Wonder - is characterized as a building or structure that has a remarkable combination of creative design, visual appeal, and noteworthy cultural or historical significance. It is evidence of the creativity, talent, and inventiveness of people. Such a structure frequently defies accepted building conventions by employing unusual materials, cutting-edge engineering, or innovative spatial arrangements to produce a striking visual and tactile effect. Any built environment, from imposing public works to intricate residential complexes to unique individual buildings, that is renowned for its structural beauty, striking artistic merit, and capacity to inspire awe, inspiration, or in-depth contemplation of its form and function is considered an architectural wonder in this context**.**

Bottleneck Effect - It describes a condition on a bridge or highway that seriously hinders or decelerates the regular flow of traffic. This phenomenon usually happens when several traffic lanes combine into fewer lanes, or when the roadway's available capacity is decreased by accidents, road construction, or other obstructions. Congestion builds up, travel times lengthen, and overall traffic efficiency is decreased when the number of vehicles trying to pass through the restricted area surpasses its capacity. Other systems can also exhibit the bottleneck effect, where a limited capacity point limits the flow of information or resources, slowing down the entire process.

Bridge Rehabilitation - It describes the procedure of strengthening, repairing, or restoring an existing bridge structure in order to increase its service life, ensure its structural integrity, and improve its functional performance. Rehabilitating deteriorated components, strengthening load-bearing elements, restoring damaged parts, enhancing design features to meet modern standards, and putting protective measures against environmental factors into place are just a few of the engineering interventions that are part of this extensive process. Enhancing the bridge's ability to safely and effectively handle present and future traffic demands is the main goal of bridge rehabilitation. Any flaws that may compromise the bridge's long-term durability and safety must also be fixed.

Bridge Widening - It refers to expanding an existing bridge structure wider. In order to meet higher capacity demands, enhance safety, or improve traffic flow, this frequently involves constructing additional lanes for bicycle paths, pedestrian walkways, or vehicle traffic. In order to preserve the bridge's structural integrity and functionality both during and after construction, the procedure typically involves structural modifications such as extending the bridge deck and supports. It may also present considerable engineering challenges. Bridge widening is a strategic infrastructure development that aims to improve transportation efficiency and alleviate congestion in this context.

Brittle Parts - refers to a substance that, under stress, has a tendency to break or fracture with little to no plastic deformation. These materials—like some metal alloys used to build bridges—are distinguished by their inability to absorb large amounts of energy before failing, which causes abrupt and frequently disastrous breaking. According to this study, brittle parts are parts of structural systems, such as metal sheets, that are prone to breaking under different loads or environmental circumstances, even though they are solid, potentially endangering the structural integrity.

Connectivity - It has tasks associated with connecting various transportation hubs so that users can travel smoothly and effectively. The complex network of routes and systems that connect different forms of transportation, including roads, railroads, waterways, and airplane routes, is referred to as connectivity in this context. This integration improves accessibility and cuts down on travel times by enabling smooth transitions between various stages of a journey. By maximizing the flow of people and goods, effective connectivity promotes social interaction, economic growth, and environmental sustainability, making it essential for urban planning and regional development. It includes both digital information systems and physical infrastructure that give travelers access to real-time data and direction.

Cost-benefit Analysis - It describes a methodical approach to weighing the costs and advantages of a project, choice, or policy. Using this analytical method, the total expected costs and benefits over a given time period are identified, quantified, and compared. The main objective is to ascertain whether the advantages outweigh the disadvantages in order to establish a solid foundation for wise decision-making**.**

Daily Stresses - These are situations in which a person runs into uncomfortable or challenging times in their daily lives. A person's general mental and emotional load may be intensified by these circumstances, which may cause uneasiness, anxiety, or distress. Daily stressors include, for instance, passing an unsafe bridge, getting caught in traffic, having to meet a strict deadline, or dealing with interpersonal conflicts

Durability - it refers to how long a bridge can last without breaking. Durability is crucial for a bridge, maintaining the structure and linking two different places for a longer period of use.

Economic Activity - It refers to the activities or procedures that take place within a certain economic system and include the production, distribution, and consumption of resources, goods, and services. Broadly speaking, it includes all human activities meant to generate income, meet needs, and enhance the material well-being of people and communities. This covers a broad spectrum of operations, including trade, manufacturing, agriculture, finance, and

services. Natural resources, government regulations, consumer demand, and technological developments all have an impact on the volume and character of economic activity. Analyzing market trends, economic growth, and an economy's general health requires an understanding of economic activity.

Engineering Ingenuity - It describes the imaginative and creative use of engineering concepts and knowledge to plan, create, and carry out solutions for difficult issues. This entails using technical know-how, scientific knowledge, and a methodical approach to get past challenges, enhance current systems, and develop new technologies or procedures. It denotes the careful and creative application of engineering knowledge to attain the best results, boost productivity, and guarantee sustainability in any given circumstance, frequently going beyond the bounds of accepted methods.

Geographical barrier - It refers to a natural feature, like rivers, that makes it difficult for humans to go from one place to another. The bridge is one of the solutions for having these types of geographical barriers.

Hidden Risk - It describes dangers that could materialize but are not obvious or simple to identify. Because of their quiet uncommonness, or lack of thorough information, these risks might be missed in initial analyses. They may arise as a result of complex relationships within a system, latent system vulnerabilities, changing socioeconomic factors, or unanticipated environmental changes.

Improving Mobility - facilitating the safe and effective movement of people and products through transportation networks and systems. In this sense, it refers to policies, infrastructure improvements, and technical breakthroughs meant to maximize traffic flow, lessen congestion, enhance accessibility, and guarantee the safe transportation of people and goods. This includes all forms of transportation, such as air, sea, rail, and road, with an emphasis on making movement smooth and dependable for all users while taking sustainability and environmental effects into account.

Pedestrian Demand - refers to the total number of people seeking to use a bridge or comparable structure for activities that mostly involve walking, bicycling, or other non-motorized transportation. Numerous factors, such as population density, the bridge's overall design and accessibility, the presence of public amenities, and its proximity to residential and commercial areas, all have an impact on this demand.

Quality of life - it refers to a point of satisfaction for a person that includes a variety of elements, including their physical and mental well-being, beliefs, social connections, and relationship to notable elements of their surroundings. The participants perceived contentment with their living circumstances, availability of resources, and general well-being will be utilized to assess their quality of life in this study, especially in light of rainwater harvesting and how it affects their day-to-day activities.

Stability - refers to how steady the bridge is in having to withstand forces and loads from any kind of disaster, like earthquakes, wind loads and moving loads from any type of vehicles. Stability can also vary on the design of a bridge.

Structural Enhancements - refers to improvements or changes made to a bridge's structural framework. These improvements are intended especially to strengthen its built-in safety features and increase its operational robustness, which will guarantee a longer service life. Additionally, these enhancements frequently seek to maximize and enhance the bridge's overall performance by supporting heavier loads, adjusting to environmental stresses, or promoting more efficient traffic flow.

Traffic Congestion - It concerns the state of vehicles that are slowed down or stuck on the road because of heavy traffic. According to this study, traffic congestion is the term used to describe the considerable delays and slowed speeds that cars encounter on the roads, which frequently arise from an imbalance between traffic demand and road capacity. Longer wait times, longer travel times, and a decline in the overall effectiveness of traffic flow are its defining characteristics. Numerous factors, such as traffic incidents, road infrastructure constraints, vehicle volume, and signal timing, can contribute to this phenomenon, which can have detrimental effects on the environment and the economy.

Vital Conduits - It refers to the most crucial component for something to work, acting as vital channels or pathways that allow vital resources, data, or energy to pass through. The overall functioning, stability, and success of a system, organization, or process depend on these conduits, and performance and results are directly impacted by their integrity.

CHAPTER 2

Review of Related Literature and Studies

This chapter presents a review of the related literature and studies, following a thorough search conducted by local and foreign researchers. Those included in this chapter aid in familiarizing oneself with relevant and related information to the current study.

Foreign Literature

The Monash Freeway Upgrade in Victoria, Australia, is a clear example of how road widening and bridge improvements can strengthen the transportation system. The project included adding new lanes, upgrading existing bridges, and putting in place modern traffic management systems to reduce congestion and address future travel needs. Major Road Projects Victoria (2021) reported that these upgrades made travel times more reliable and improved road safety, while also giving a boost to economic growth. This large-scale infrastructure initiative highlights how widening existing structures can deliver both functional and socio-economic benefits.

According to the study of Schwarz et al. (2025), the use of thermally prestressed post-installed reinforcement is a method for strengthening reinforced concrete members. Their study revealed that this technique effectively addresses structural deficiencies caused by the self-weight of the structure. The study also showed that thermally pre-stressing can increase stiffness, reduce deflections by 33%, and lower crack depths at maximum load. It also improved serviceability performance

by the remaining over 90% effective up to 60% of the maximum load, while minimizing the crack width by up to 45%. The outcome of this study shows that the method has potential in extending the service life of reinforced concrete structures.

Complimenting this study, Moghandam et al (2024) provided a comprehensive study on the application of Carbon Fiber Reinforced Polymer (CFRP) in retrofitting steel structures, emphasizing several influencing parameters. Their study found that a higher elastic modulus of CFRP significantly improves bond strength, load-carrying capacity, and also the flexural behavior. Their review of the CFRP revealed that adhesive properties were also critical, with nonlinear adhesives showing superior failure loads compared to linear ones. The study further highlights the importance of surface preparation, pre-stressing, and anchorage systems, all of which enhance the chance of fatigue life and delay crack distribution, therefore improving the durability of strengthened steel elements.

In line with the previous study of Haber et al. (2022), they found that ultrahigh-performance concrete (UHPC) offers a viable, durable, and efficient option for bridge preservation and repair (P&R) application. Their study combines both laboratory research and field pilot projects to validate the effectiveness of UHPC in deck overlays, link slabs, and beam-end repairs, and provides specific design and construction guidelines for these applications. Significantly, the author argues that UHPC should be integrated into standard P&E asset toolkits, as it enables service life and potentially reduces lifecycle costs. This report aims to catalyze wider adoption by refining the technical basis for agency specifications and best practices.

According to the research review of Aurier et al. (2023). Accelerated Bridge Construction (ABC) methods, emphasizing prefabricated bridge elements and systems (PBES), material, and connections, with a focus on cold weather adaptability. Their study is a combination of an international case study on deck panels, beams, girder systems, and closure joints, highlighting that certain connection technologies remain effective at low temperatures. They discovered that the adaptability of ABC in severe winter climates is promising, particularly when durable materials are selected for connection. Their findings stress the need for continued research on sealing and repairing suitable products for extreme conditions, ensuring both durability and broader application in northern regions.

As for the bridge to become future proof, Mitoulis et al. (2022) Emphasized the importance of resilience in bridge and transport networks, focusing on sustainability, smart monitoring, and adaptive design. They highlighted the use of digital technologies and life cycle management to enhance bridge performance and the recovery disruptions. The study promotes future proof infrastructure through the use of innovation, multidisciplinary collaboration and also resilience-based design bridge engineering

Local Literature

In the study of Siman (2023). A meta-analysis was conducted for the research design to analyze and combine information from multiple studies. The findings of the study, the Philippine construction industry is in a state of significant growth in the

coming years. Highlights the view of the construction industry and the challenges in supply, material shortages. It emphasizes the practicability and cost efficiency in local projects and is considered in the design and planning phase.

Roads and bridges are important parts of any infrastructure; the reason is that they connect people and the economy. Therefore, to maximize their functionality longer, they go through maintenance. Roads and bridges in the Zamboanga Peninsula region of the Philippines have deficiencies, according to empirical data obtained from the Department of Public Works and Highways (DPWH) and other relevant government agencies (Moreno, 2023). The deficiencies come from insufficient funding, lack of skilled personnel, and insufficient maintenance strategies; these deficiencies cause a huge impact, such as heightened traffic congestion, increased accidents, and disruption to economic activities. According to these findings, the research proposes some recommendations that can help solve the problem. This recommendation includes allocating a greater budget, implementing capacity-building programs for maintenance personnel, and adopting preventive maintenance strategies. The study shows how important maintenance is when it comes to a structure, ensuring its long-term functionality.

Improving the structural integrity of a road bridge using the gathered data about its previous malfunctions. According to M.J. Adarne and M. Henry (2024) states that road bridges in the Philippines are not safe for users after natural disasters such as typhoons, earthquakes, and floods. The research analyzed the gathered data from the government. The data collected from 2020 to 2021 are the impacts of natural disasters

at the regional levels. The study focuses on using this information to help government agencies have an immediate response for mitigating the effects of natural disasters and rebuilding road bridges with high structural integrity.

Based on the study of Tuason et al (2023), the study focuses on analyzing the seismic vulnerability of MacArthur Bridge. CSiBridge was used in Modeling. The analysis shows the result that the yield displacement and Maximum displacement when subjected to gravity loads from the method capacity spectrum. In conclusion, using the Method serves as a complete standard for evaluating structural stability.

In the study of Navarro and Latigar (2022) on the State of Road and Rail Transport infrastructure in the Philippines, they concluded that the country's bridge and road system continues to face significant challenges in meeting growing transportation demands. They highlighted that although the government has made progress through various national programs, a large portion of bridges remains in need of rehabilitation and improvement to ensure long-term stability and safety. They also emphasized the necessity of adopting a comprehensive and long-term infrastructure plan that can promote sustainability, enhance connectivity, and strengthen the capacity of local government units in project implementation. They also recommended the use of modern engineering practices and the establishment of regular maintenance programs to help extend the lifespan of bridges and prevent further damage. Overall, their conclusion highlights the need for consistent investment, strategic planning, and innovation in infrastructure development to build a safer, stronger, and more efficient transportation network for the country.

Foreign Studies

Mohseni et al. (MDPI): In this study, the flexural performance of Fiber Reinforced Polymer (FRP) with Geopolymer Concrete (GPC) is tested. This study used theories for applying; this includes AC144.1R-15, CAN/CSA S80612, parabolic stress block theory, and equivalent rectangular stress block theory. In conclusion, the parabolic stress block theory test result is that it has overestimated capacity, and the CAN/CSA S806-12 theory has a result of the most accurate and conservative predictions.

Colford et al. (ICE) 2024. This study explains structural health monitoring (SHM) as another way to check the condition of structures or bridges to find damage beforehand. They use some approach that looks at how likely damage or failure could be serious. This helps decide when and where to inspect or fix some parts of a structure in the most cost-effective way. Their method uses smart models to connect damage data to possible failures, helping to choose the best maintenance actions to keep structures safe to use daily and reduce costs. The system also guides inspections based on the value of the information they gave, lowering unimportant checks while improving many safety decisions.

The experimental study of Zhang et al. (2025) on the G35 Expressway in China, which used Recycled Concrete Aggregate (RAC) shows that mix design and shape optimization can achieve a carbon reduction of about 9% compared to Natural

aggregate concrete (NAC). This validates the use of RAC for sustainable bridge components

Ebrahimzadeh et al. (2025) conducted a thorough investigation on the structural performance of glass fiber-reinforced polymer (GRFP) concrete decks. They emphasized their potential to replace conventional steel reinforcement in bridge and maritime structures. The study found that GFRP-reinforced decks offer higher durability, corrosion resistance, and longer service life, which can extend beyond 50 years, especially in harsh environments. Their findings highlight that key design factors such as reinforcement ratio, deck geometry, and concrete strength significantly influence the flexural and shear capacity.

Van der Velde et al. (2020) introduced the concept of Smart bridge, which emphasized digital integration, sensor technology, and modular materials for efficient Infrastructure replacement. Their study demonstrated how smart bridges improve monitoring, maintenance, and sustainability. The study also highlights the innovation in bridge engineering, promoting safer, adaptive, and cost-effective infrastructure systems for urban and transport development.

For the context of materials in bridge construction, Saha et al. (2021) reviewed various patching materials used for concrete bridge deck repairs, focusing on their durability, bonding strength, and resistance to environmental deterioration. The study identified polymer-modified concrete and geopolymer composites as effective solutions for extending bridge service life. They concluded and emphasized that

material innovation is necessary to ensure sustainable, long-lasting, and cost-efficient bridge maintenance

In the study of Khedmatgozar et al. (2021), applying Laminated Rubber Bearing Pads (LRBPs) between piers/columns and girder should be one of the considerations because it eases the horizontal movement due to the seismic movement and continuous movement of vehicles on the bridge. Also, LRBPs help to reduce the relative displacement between the superstructure and substructure, increase the effective stiffness. This study shows the analysis and design procedure of using an LRBPs in a bridge to isolate bridges seismically, and shows the cost-efficient

As for the vertical support of the bridge, Balaji and Manikandan (2020) conducted a study on the behavior of reinforced concrete bridge piers under various seismic zonal conditions. Their study revealed that pier height, geometry, and foundation type significantly influence bridge stability. This study concluded that the properly designed piers are essential in supporting vertical and lateral loads, ensuring overall safety and resilience.

Local Studies

USHER - Uy, F.A. (2022), A low-cost system designed at the MAPUA University, which is used to monitor the vibration within a structure using the baseline information of the said building. After the disaster, there's concern about evacuating, but also, it is still safe to use the building again. With the use of the system, if discovered with anomalies are discovered between the baseline data and patterns

during and after the earthquake, the structure is suspected to suffer certain damage during the disaster. thanks to this system, it validates the structure's real-time lifespan monitoring of the structure's integrity.

De Villena & Bordios (2021). They conclude that with the current economy of the Philippines, it is required to select a feasible investment in the infrastructure in the Philippines, emphasizing the need for proper planning and quality materials for the building of infrastructure to avoid conflict regarding deficiency and social infrastructure. economic development and transportation infrastructure are closely related. by the reason of relationship of transportation, which influences activity between regions, efficiently moving goods and labor used in production.

DPWH (2025), Mindanao plays a role in the Philippines' participation in regional cooperation initiatives. Despite being rich in natural resources, Mindanao has the highest poverty incidence in the Philippines as a whole.

Mindanao Road Sector Projects involve 7 road subprojects, all located in the Zamboanga Peninsula, together with 3 bridges along the way, which will improve the contribution to improve operations across Mindanao. it supports the potential increase to the economy through the new road infrastructure development in Mindanao.

Metro Manila Bridges Project Administration Manual, DPWH (2025), About the management cluster of bridge management connection, providing an overview of planning difficulties that affect the project's progression. it aligns with the focus

of enhancing transport sectors to sustain economic growth, increasing global competitiveness. The project will improve the efficiency of Metro Manila's

Road network, also improving resiliency against disasters

Tuco & Salapa (2025), a systematic review that evaluates the urban traffic management system at Digos City, a growing mid-size city in Davao del Sur. The city faces recurring traffic due to outdated ordinances, weak enforcement, and insufficient infrastructure around the city. Measurements are made and implemented, such as Ordinance No. 18-10 (Comprehensive Transport and Traffic Code of Digos City). However, these efforts have hindered the effectiveness of the city's traffic management system. The review seeks to identify prevailing strategies, recurring challenges, and promising implementations in traffic governance.

Synthesis of Related Literature and Studies

It is widely acknowledged that road and bridge infrastructure is essential to economic growth and serves as a crucial means of transportation for both people and goods. The long-term functionality of these structures, therefore, is a central concern for sustainable urban and national development.

International experience from projects like the Monash Freeway Upgrade and case studies in the UAE underscore the socioeconomic benefits of widening existing structures to reduce congestion and accommodate rising traffic volume. This modernization effort is backed by specialized engineering research, which confirms that structural deficiencies can be overcome using advanced techniques such as

thermally prestressed reinforcement and Carbon Fiber Reinforced Polymer (CFRP) to increase strength, stiffness, and durability. Furthermore, with bridges facing increased stress from heavier traffic and natural disasters, a focus on structural resilience and accurate load analysis, often using methods like Finite Element Analysis (FEA), is deemed essential for safe, cost-effective retrofitting and future design.

In the modern global trend of engineering construction, it highlights the resilience and long-term sustainability in design principles towards structural integrity. the idea of "Smart Bridge" is emerging; it is the system or process of sensor technology, digital integration, and modular materials for proactive maintenance, better monitoring, and effective use of infrastructure replacement. According to the studies of Van der Velde et al. (2020) and Mitoulis et al, the technique shows the adaptive design and cycle of life in management to enhance bridge strength and recovery of disruptions, which will result in safer and more affordable system infrastructure. To guarantee sustainable and long-lasting maintenance, with the study of identifying advanced solutions such as polymer-modified concrete and geopolymer composites for deck repairs for sustainable and long-lasting maintenance. Also, in achieving structural resilience due to the dynamic forces requires specialized engineering, like using Laminated Rubber Bearing Pads (LRBPs) to minimize seismic and continuous vehicular horizontal movements; nonetheless, to ensure overall stability against lateral and vertical loads under a variety of seismic conditions, reinforced concrete bridge piers have to be correctly constructed.

But the Philippines presents a complex landscape and is divided by islands, where infrastructure challenges, including issues in implementation and poor quality, result in corruption, resulting in the country being ranked among the least improved in the ASEAN region. Despite their importance, city projects like bridge rehabilitation have been shown to significantly impair commuter mobility, resulting in delays of one to two hours and raising safety concerns due to a lack of proactive and robust mitigation measures.

The course of this study is to support the local needs for innovative planning with the use of the international standard for infrastructure improvement. For example, the design and expansion of the existing Newtown Bridge should follow the standard structural engineering principles for safety and stability for a highway improvement plan that focuses on traffic flow, improved accessibility, and community benefits first, while minimizing unanticipated negative effects on neighbors and commuters during the construction phase.

CHAPTER 3

Research Methodology

Research Design

The design utilized a Descriptive Quantitative Research Design. The goal of this design is to describe the current condition and perception related to the Newtown Bridge and to quantify the data gathered from residents and commuters with regard to accessibility, safety, and traffic issues. With the use of numerical data. The researcher aims to provide factual evidence supporting the need for bridge widening and to guide the formulation of new and improved designs. This method also allows for the identification of common trends, patterns, and opinions among respondents.

Design Process:

Site Investigation

The step for physical observation is essential to evaluate the current structural integrity, paying particular attention to its current condition as a result of its deterioration, and to observe the Quirino Highway traffic condition during peak hours and the surrounding area. In the process, the perimeter of the bridge, the floor metal plate, and the documentation of the bridge are considered.

Data Collection

This is the process of supporting the Research Design using a survey questionnaire in the local area of Newtown Bridge and the surrounding district

residents, and conducting a field investigation to provide the essential data of the structure and its vicinity. In order to answer the questions established in the Statement of the Problem. Therefore, the data was collected from primary and secondary sources to guarantee a thorough approach.

Sources of data:

Primary

Source: The target sources of primary data that will be used in the survey questionnaire are local residents, Commuters, and drivers**.**

Secondary

Source: The target sources of secondary data that will be used in the survey questionnaire are NSCP, the Government, and previous studies**.**

Conceptual Design

The conceptual design focuses on the new design and widening of the existing Newtown Bridge. The proposed bridge will have a total length of 35 meters and a width of 7.6 meters, featuring a two-way vehicular lane measuring 3.05 meters per lane, along with a 1.5-meter pedestrian lane. The structure will utilize pre-cast reinforced concrete girders supported by a single central pier, and metal railings will be installed along both sides for safety. To enhance the bridge's performance during seismic events, a pod damping system will be integrated to reduce vibration and absorb

seismic energy. The design ensures compliance with the standard specifications of the Department of Public Works and Highways (DPWH) and the National Structural Code of the Philippines (NSCP, 2015)

Sample and population

The study focuses on the Newtown Bridge and the improvement of Towerville and its residents in terms of accessibility to Quirino Highway. The population of Towerville is currently unknown; therefore, the study will utilize data gathered through questionnaires distributed to 100 respondents around the area where the proposed bridge is located, including residents of Newtown, drivers, and commuters. The collected data will be used to support the implementation of a cost-efficient and practical bridge design.

Sampling Technique

The study used the sampling technique, the Purposive Sampling Technique. The residents of Towerville, as well as outsiders who may benefit from the said bridge, should ensure overall satisfaction. The data should be gathered from the Towerville occupants and from outside of Towerville, who may use the proposed infrastructure. The infrastructure should accommodate a variety of users, whether a vehicle owner or a pedestrian.

Research instrument:

The primary research instrument that will be used in this study will be a structured questionnaire. It will be designed by the researcher to collect quantitative data from residents, commuters, and motorists who frequently use or are affected by the Newtown Bridge.

The secondary instrument for this research is the Design. The researcher will use in this study a set of design and structural tools, specifically AutoCAD and STAAD Pro. These software applications will serve as engineering instruments for generating and evaluating the proposed design and widening of Newtown Bridge.

Data Gathering

The study proposed the use of Surveying, Design Software, and Cost Estimation for the Newtown Bridge. The data collected from the respondents, reflecting the needs around that area gathered directly from the families and passerby in and out of Towerville, respectively.

Surveying

The method of Questionnaire is used, and the questioned were the residents, daily commuters, and pedestrians who are accustomed to using the existing bridge or road network. Their survey was mainly aimed at evaluating their satisfaction level, accessibility perception, safety worries, and local traffic conditions near the proposed bridge site. Such a measure gave the locals' needs in numbers and also helped figure

out community concerns in terms of accessibility and safety at the bridge. Responses to the survey were gathered, recorded, and subjected to statistical analysis to serve as the basis for the next design phase.

Design Software

In this process of data gathering, after the site investigation, and based on the findings. the use of software such as Auto-CAD for designing the Bridge's Floor plan, mentioning the dimensions and structural system, STAAD for simulation of Load Distribution at the bridge, addressing the stress and failure under Live, Dead, Wind, and Seismic loads. The bridge should be in the standard NSCP 2015 when addressing the application of different loads; all must be validated according to the code.

Cost-Estimation

Lastly, the cost estimation will be conducted for the feasibility of the bridge design, which should be done using Excel to quantify the Labor, Materials, and other Building expenses during the construction of the Bridge, and will be both practical and cost-efficient.

Frequency and Percentage Method

This method is used to statistically analyze using Descriptive Statistics. It is to describe the demographic profile of the respondent in terms of age, sex, educational background, and occupation.

The formula used is:

$$P = \frac{f}{n} * 100$$

P = Percentage

f = frequency

n = number of respondents

Likert and mean method

The data that will be gathered from the questionnaire will be analyzed using the weighted mean method based on a five-point Likert scale. This method will be used to determine the respondent's level of agreement or perception regarding the overall condition of the Newtown Bridge and its accessibility

Rating	Verbal interpretation	Rate
5	Excellent accessibility	4.5 - 5
4	Good accessibility	3.5 – 4.4
3	Moderately accessibility	2.5 - 3.4
2	Poor accessibility	1.5 – 2.4
1	Very poor accessibility	1.0 – 1.4

Table 3 *Likert Scale*